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Gynandromorph records of *Melissodes trinodis* and *Melissodes communis* (Hymenoptera, Apidae) from North Dakota, USA

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Abstract

Bees that express both male and female characteristics are known as gynandromorphs. Here we report and describe two specimens that represent the first documented gynandromorphs of *Melissodes trinodis* Robertson and one specimen of *Melissodes communis* Cresson (Hymenoptera: Apidae) that represents only the second known case. All three specimens were collected in North Dakota, USA and exhibit a mosaic pattern of gynandromorphy.

Keywords

Apoidea, Eucerini, gynandromorph, morphology

Introduction

Gynandromorphs are individuals that are usually genetic chimeras expressing both male and female characteristics and this phenomenon has been found in most insect orders (Pereira et al. 2010; Lightburn et al. 2022). Within bees (Hymenoptera: Apoidea: Anthophila), approximately 140 gynandromorph specimens are described

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from all bee families (Lightburn et al. 2022). Although documented in over 30 bee genera, gynandromorphy has been reported more frequently in *Andrena* Fabricius (Hymenoptera: Andrenidae) and *Megachile* Latreille (Hymenoptera: Megachilidae) (Michez et al. 2009; Hinojosa-Díaz et al. 2012; Parys et al. 2022).

Gynandromorphy has been documented in many different forms in bees but is most commonly found as mosaics where no clear distribution of male and female characteristics can be discerned (Wcislo et al. 2004). Other less common gynandromorph patterns documented in bees include male and female characteristics separated bilaterally, transversally, and various anterior/posterior separations (Dalla Torre and Friese 1899; Wcislo et al. 2004; Michez et al. 2009).

Although *Melissodes* are one of the more commonly collected apids among researchers in North America, only one known case of gynandromorphy has been documented in the scientific literature (Cockerell 1906). This specimen mentioned by Cockerell (1906), *Melissodes hortivagans* Cockerell (=*M. communis* Cresson), was collected in Fedor, TX and described as a 'partial gynandromorph' with a half yellow (right side) and black (left side) clypeus and labrum. Here we report one individual of *M. communis* and two individuals of *M. trinodis* Robertson from North Dakota, USA exhibiting gynandromorphy. All three individuals exhibited the mosaic pattern described by Michez et al. (2009) or would be partial bilaterals in the system of Dalla Torre and Friese (1899).

Methods

The *M. communis* specimen was collected in a pitfall trap (473 ml Solo cup filled half of the depth with a 50% propylene glycol/water solution) that was active for 7 days (June 10–17, 2021) in the Little Missouri National Grasslands, Billings County, North Dakota (47.30828, -103.45804). Both *M. trinodis* specimens were collected with colored (blue, yellow, and white) pan traps (473 ml pan trap filled with soapy water) that were active for 24 hours. The *M. trinodis* specimens were part of a greater survey effort to sample grassland bee communities in North Dakota (Pei et al. 2022). One gynandromorph was collected in a sampling event on July 26, 2017 from Long Lake National Wildlife Refuge, Burleigh County, North Dakota (48.81845, -100.22222). A second gynandromorph was collected on a July 15, 2018 sampling event in Agnes Marsh Waterfowl Production Area, Grand Forks County, North Dakota (48.08277, -97.72434).

Here, we describe each specimen and provide detailed photographs of the external morphology. For each specimen, the following external morphological measurements were made: total body length (mm), head width (taken from widest part of eyes) (mm), intertegular distance (ITD) (mm), abdominal width (taken from widest part of abdomen) (mm), scape + pedicel length (mm), and flagellum length (mm) (Table 1). All photographs of *M. trinodis* were taken with a Canon EOS 6D Mark II Digital SLR and photographs of *M. communis* with a Leica DMC 4500. The *M. communis* specimen is housed at the USDA Northern Plains Agricultural Research Laboratory native bee collection (Sidney, MT) and the *M. trinodis* specimens are located at North Dakota State University in the School of Natural Resources Sciences (Fargo, ND).

Table 1. Morphological measurements (mm) of total body length, head width, ITD, abdomen width, scape + pedicel length, and flagellum length of *M. communis* and *M. trinodis*. GF= Grand Forks specimen, BC= Burleigh County specimen.

	Melissodes communis	***Melissodes trinodis* (GF)**	***Melissodes trinodis* (BC)**
Total Body Length	11.26	11.49	11.21
Head Width	3.81	3.73	3.86
ITD	2.4	2.91	2.91
Abdomen Width	4.01	4.3	4.5
Scape + Pedicel Length	0.78	0.98	0.95
Flagellum Length	2.91	N/A	2.72

Results

Melissodes communis

This specimen was collected along with 106 other *Melissodes* specimens collected in the same 2021 sampling effort. The specimen exhibits primarily bilateral asymmetric yellow male coloration (right side) and dark female (left side) coloration of clypeus and labrum (Fig. 1A; labrum not visible in photo). Both antennae have 12 segments. Other than the clypeus, labrum and antennae, specimen appears to be male (e.g., legs lacking tibia scopal hair, exhibiting male genitalia) (Fig. 1B–D).

Melissodes trinodis

These specimens were collected along with 1,252 (Burleigh specimen) and 1,126 (Grand Forks specimen) *Melissodes* specimens in the same year sampling effort. Both specimens exhibit bilateral asymmetric male/female (yellow/dark) coloration of clypeus and labrum, with male-associated yellow coloration found on the left side for the Grand Forks specimen and on the right side for the Burleigh specimen (Figs 2A, 3A). All other external characteristics of each specimen appear female (Figs 2B–D, 3B–D). However, the antennae were not present for the specimen from Burleigh County so we cannot ascertain the number of antennal segments. Additionally, one hind tibia is missing from the Grand Forks specimen and, thus, we cannot determine if scopal hairs were present.

Discussion

We describe the first gynandromorphs from *Melissodes trinodis* and the second of *M. communis*. Other than Cockerell (1906), these are the first reports of gynandromorphy from this genus in the scientific literature, and all three specimens appear to follow the mosaic pattern described by Michez et al. (2009). However, *M. communis* and one specimen of *M. trinodis* (specimen from Grand Forks County) display a 'patchiness' of the yellow coloration on their clypeus (see Figs 1A, 2A). This patchiness is also seen on the labrum for *M. trinodis*. Due to the lack

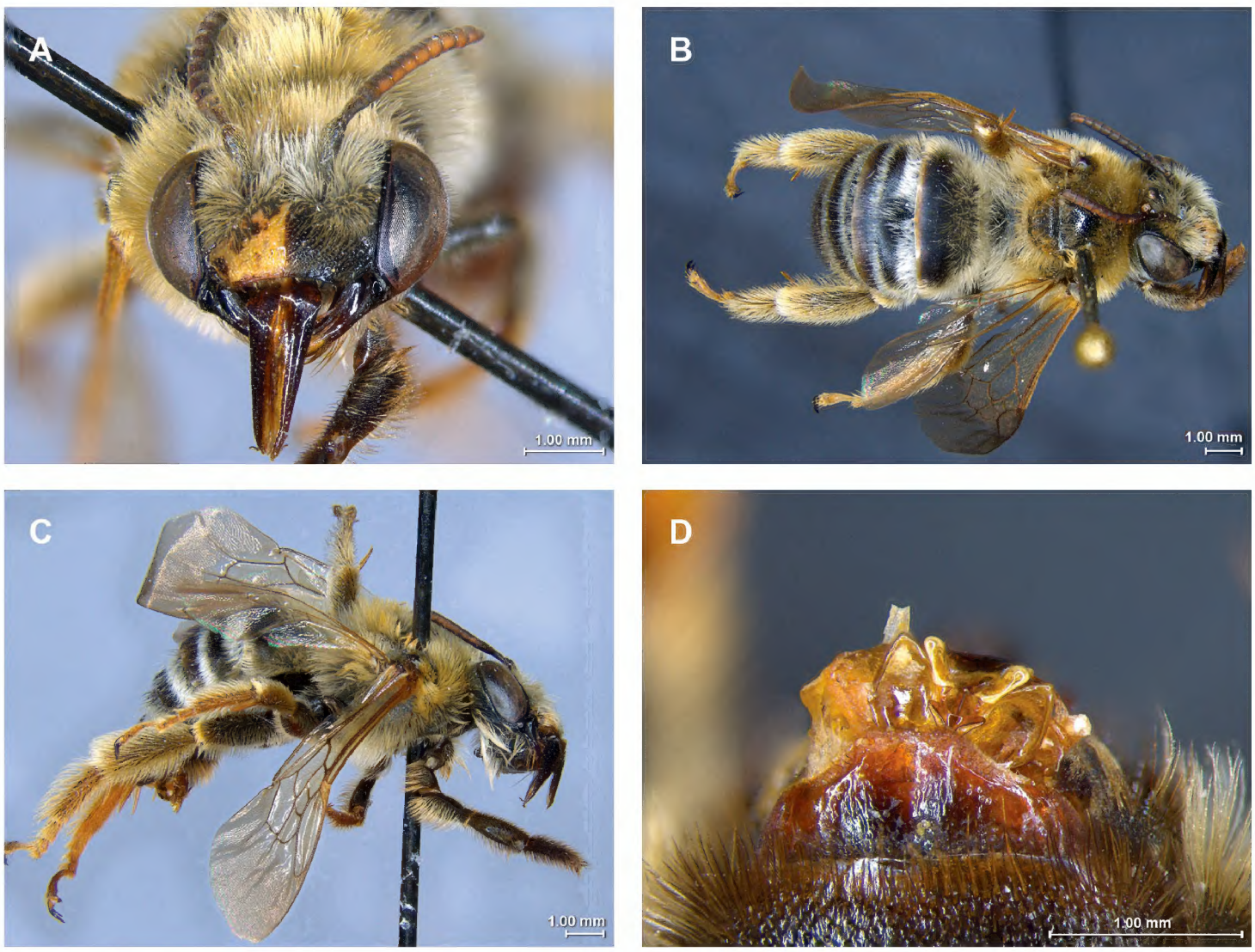

Figure 1. Gynandromorph of *Melissodes communis* collected from Billings County, North Dakota, USA **A** face **B** dorsal view **C** lateral view, and **D** male genitalia (partially exposed).

of sharp morphological distinctions of male and female characters (e.g., clypeus yellow color not uniform), these two specimens could be considered mosaics by Michez et al. (2010) or would be called partial bilaterals in the system of Dalla Torre and Friese (1899).

Both of the bee species in this study are widely distributed in North America, with *M. communis* found throughout the United States, southern Canada and Mexico, whereas *M. trinodis* is primarily found in the eastern half of the United States but can also be found in Canada and Mexico. *Melissodes communis* is polylectic, feeding on multiple pollen sources, whereas *M. trinodis* is primarily considered an Asteraceae specialist and one of the main visitors of flowering cultivated sunflower (Portlas et al. 2018). Jones et al. (2021) was able to observe a gynandromorph bee (*Xenoglossa pruinosa* Say (Hymenoptera: Apidae)) foraging prior to collection, and, thus, was able to glean some behavioral information. Since the specimens described here were collected in passive traps, no behavioral observations could be collected.

Prior to these specimens, only eight other gynandromorphic individuals from tribe Eucerini had been documented, (Cockerell 1906; Jones et al. 2021; Parys et al. 2022), suggesting gynandromorphs may be rare within Eucerini compared to

Figure 2. Gynandromorph of *Melissodes trinodis* collected from Grand Forks County, North Dakota, USA **A** face **B** dorsal view **C** lateral view, and **D** abdomen.

other bee groups. Alternatively, there could be a bias in finding/collecting gynandromorphs from Eucerini or there is a lack of reporting them. In addition to *Melissodes* and *Xenoglossa*, other Eucerini genera in which gynandromorphs have been documented are *Alloscirtetica* Holmberg (Hymenoptera: Apidae) (Urban 1999), *Florilegus* Robertson (Hymenoptera: Apidae) (Parys et al. 2022), and *Tetralonia* Spinola (Hymenoptera: Apidae) (Dalla Torre and Friese 1899). It is unclear why gynandromorphy is uncommon or poorly documented within Eucerini. However, numerous explanations are thought to cause gynandromorphy in bees (or other arthropods) including various developmental mechanisms (Jones et al. 2021), endosymbiotic bacteria (Narita et al. 2010), epigenic causes (Sommaggio et al. 2021), and numerous environmental stressors such as temperature (Drescher and Rothenbuhler 1963) and pollutants (Dantchenko et al. 1995; Olmstead and LeBlanc 2007). The presence of gynandromorphs in wild bee populations is considered rare and the causes unknown and, thus, further research and documentation is widely needed to elucidate the causes of gynandromorphy (Jones et al. 2021; Parys et al. 2022). There has been an increase of documentation of gynandromorphy in wild bees in recent literature (Jones et al. 2021), but whether this is an upsurge of interest by the scientific community to document this occurrence or an increase in a causation of this phenomenon remains unknown.

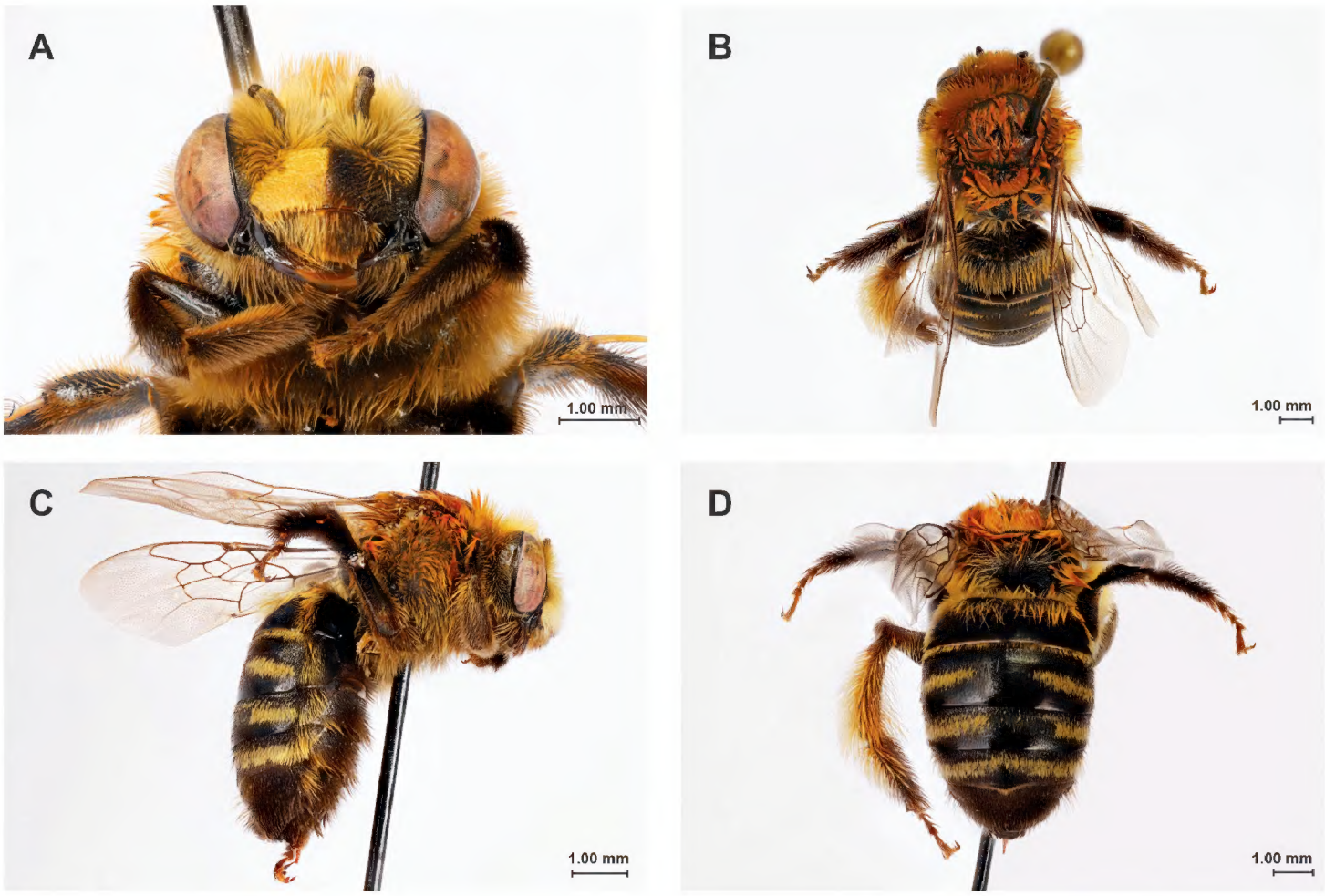

Figure 3. Gynandromorph of *Melissodes trinodis* collected from Burleigh County, North Dakota, USA **A** face **B** dorsal view **C** lateral view, and **D** abdomen.

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